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Ion beam synthesis and investigation of nanocomposite multiferroics based on barium titanate with 3d metal nanoparticles

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Abstract

Samples of nanocomposite multiferroics have been synthesized by implantation of Co+, Fe+, and Ni+ ions with an energy of 40 keV into ferroelectric barium titanate plates to doses in the range (0.5-1.5) × 1017 ions/cm2. It has been found that nanoparticles of metallic iron, cobalt, or nickel are formed in the barium titanate layer subjected to ion bombardment. With an increase in the implantation dose, the implanted samples sequentially exhibit superparamagnetic, soft magnetic, and, finally, strong ferromagnetic properties at room temperature. The average sizes of ion-synthesized 3d-metal nanoparticles vary in the range from 5 to 10 nm depending on the implantation dose. Investigation of the orientation dependence of the magnetic hysteresis loops has demonstrated that the samples show a uniaxial ("easy plane") magnetic anisotropy typical of thin granular magnetic films. Ferromagnetic BaTiO3: 3d metal samples are characterized by a significant shift of the ferromagnetic resonance signal in an external electric field, as well as by a large (in magnitude) magnetodielectric effect at room temperature. These results indicate that there is a strong magnetoelectric coupling between the ferroelectric barium titanate matrix and ion-synthesized nanoparticles of magnetic metals. © 2013 Pleiades Publishing, Ltd.

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